UNIVERSAL VACUUM COUPLING FOR CYLINDRICAL TARGET

Field of the invention.

The present invention relates to a coupling system to releasably affix a cylindrical target to a spindle.

Background of the invention.

Cylindrical magnetrons with rotating cylindrical targets have been used more and more over the last decade. A cylindrical target in operation must be supported, rotated, cooled and energized. Normally the sputtering installation is energized through one removable spindle at one end of the cylindrical target (cantilever mode) or two removable spindles at the two ends of the cylindrical target.

Supporting, rotating, energizing and cooling of the cylindrical targets is all done through the spindles. One side of the cylindrical target, the outer side of the target material operates under vacuum while the other side of the cylindrical target, the inner side, operates under substantially higher pressures. Water leaks occurring at the interface between the spindle and the cylindrical target have resulted in the development of various vacuum coupling and sealing systems.

US-A-5,591,314 (Vanderstraeten, now Bekaert VDS) discloses a coupling system to releasably affix a cylindrical target to a spindle by means of a threaded spindle collar engaging threads on the outside surface of the target.

EP-B1-1 092 109 (Sinvaco, now Bekaert VDS) discloses a coupling system where the cylindrical target is axially slidable over a first end portion of the spindle. The spindle terminates in a flange portion and the cylindrical target has a flange extremity. The coupling system further has a clamping ring which is composed of two or more clamp segments. Each clamp segment has a clamp recess. This clamp recess encloses both the flange portion and the flange extremity so as to couple the spindle to the cylindrical target.

EP-A1-1 106 893 (Unaxis) discloses yet another coupling system. The aim of this system is to avoid the helical groove and spring of US-A-5,591,314. This is done by providing the cylindrical target with

a groove at its ends. The coupling further comprises a first ring and a second ring. The first ring or part of the first ring engages with the groove of the cylindrical target and the second ring engages with the spindle. Both the first ring and the second ring are connected with one another to keep the cylindrical target and the spindle under an axial tension. Tautening occurs only between the rings.

US-B1-6,375,815 (Lynn) discloses a coupling system where the spindle has a flange portion and the cylindrical target a flange extremity. Both the spindle and the cylindrical target are held together by means of a split clamping collar and a retainer ring. The split clamping collar encloses the flange portion of the spindle and the flange extremity of the cylindrical target. The split clamping collar has inside threads. The retainer ring is slidable over the spindle and rotatable against the spindle. The retainer ring has outside threads, which are adapted to engage with the threads of the split clamping collar in order to couple the spindle to the cylindrical target.

In the Vanderstraeten embodiment the threaded end of the cylindrical target only fits with the Vanderstraeten spindle collar.
In the Unaxis embodiment the grooved end of the cylindrical target only fits with the first Unaxis ring.
In the Sinvaco embodiment the flange extremity of the cylindrical target has an outwardly angled step.
In the Lynn embodiment the flange extremity of the cylindrical target has an inwardly angled step.
Adapting one type of cylindrical target to another type of spindle means an irreversible destruction of some parts at the end of the cylindrical target.
So various systems exist next to each other. The result is that once a coater has bought a sputter installation with determined spindles he is obliged to stick to determined cylindrical targets.

Summary of the invention.

It is an object of the present invention to avoid the drawbacks of the prior art.

It is also an object of the present invention to increase the interchangeability of cylindrical targets.

It is yet another object of the present invention to avoid changes to existing cylindrical targets or to existing spindles.

It is an object of the present invention to enable coupling of spindles of one system to cylindrical targets of another system.

According to a first embodiment of the invention there is provided a coupling system to releasably affix a cylindrical target to a spindle.

The coupling system comprises :

a) a spindle which terminates in a flange portion ;
b) a cylindrical target which has at its end a grooved outside circumferential surface ;
c) an interface ring which has a circumferential inner surface adapted to engage with the grooved outside circumferential surface of the cylindrical target ; the interface ring further has a flange extremity ;
d) a clamping ring which is adapted to engage with the flange portion and with the interface ring in order to hold the cylindrical target to the spindle ;
e) one or more sealing rings between the spindle and the cylindrical target.

The interface ring is different from the clamping ring.

The cylindrical target has an outer end diameter and the interface ring has an inner diameter which may be - at least locally - greater than or equal to the outer end diameter of the cylindrical target.

The terms outer end diameter and inner diameter refer to the main part of resp. the cylindrical target and the interface ring, not taking into account local grooves or local protrusions.

According to a second embodiment of the invention there is provided a coupling system to releasably affix a cylindrical target to a spindle. The coupling system comprises :

a) a spindle terminating in a flange portion ;
b) a cylindrical target having at its end a grooved inside circumferential surface ;
c) an interface ring having a circumferential outer surface adapted to engage with the grooved inside circumferential surface of the cylindrical target ;
d) a clamping ring which is adapted to engage with the flange portion and with the interface ring to hold the cylindrical target to the spindle ;
e) one or more sealing rings located between the spindle and the cylindrical target.

The cylindrical target has an inner end diameter and the interface ring has an outer diameter which may be - at least locally - smaller than or equal to the inner end diameter of the cylindrical target. The terms inner end diameter and outer diameter refer to the main part of resp. the cylindrical target and the interface ring, not taking into account local protrusions or local grooves.

Within the context of the present invention, the term cylindrical target both refers to a cylindrical target made out of a backup tube covered with a layer of target material and to a self supporting cylindrical target which is completely made out of the target material.

The grooved outside or inside circumferential surface of the cylindrical target may be a helical groove with e.g. at least one revolution. A spring adapted to the helical groove can be inserted between the

cylindrical target and the interface ring. In this case the tautening action occurs between the interface ring and the cylindrical target.

In one preferable embodiment, the interface ring further may have a flange extremity.
The clamping ring may be preferably composed of two or more clamping segments. Each segment may have an inwardly oriented clamp recess. The clamp recess encloses the flange portion of the spindle and the flange extremity of the interface ring. Such a clamping ring can easily be removed from the coupling system.
More than two clamping segments may be advantageous in comparison with two clamping segments because of a higher number of point contacts in case the clamping ring gets hotter than the target.

So the outer surface of the interface ring with its flange extremity fits with the split clamping ring of e.g. the Sinvaco embodiment. As a result, thanks to the interface ring the grooved (both helical and non-helical) cylindrical targets now also fit with another type of coupling.

In another preferable embodiment, the interface ring may have radially protruding parts, e.g. in the form of a helix. The clamping ring engages with these protruding parts and, for example, may be screwed on the interface ring.

In a practical embodiment of the invention, the coupling system has a cylindrical target ending with a recess. The interface ring has a protruding part meeting this recess to facilitate positioning of the interface ring vis-à-vis the target.

Brief description of the drawings.

The invention will now be described into more detail with reference to the accompanying drawings wherein

- FIGURE 1 is a cross-section of a first embodiment of a coupling system according to the present invention ;
- FIGURE 2 is a detailed view of a first embodiment of a coupling system according to the present invention ;
- FIGURE 3 is a side view of a first embodiment of a coupling system according to the present invention ;
- FIGURE 4 is a cross-section of a first alternative of a first embodiment of a coupling system according to the present invention ;
- FIGURE 5 is a cross-section of a second alternative of a first embodiment of a coupling system according to the present invention ;
- FIGURE 6 is a cross-section of a second embodiment of a coupling system according to the present invention.

Description of the preferred embodiments of the invention.

FIGURE 1, FIGURE 2 and FIGURE 3 illustrate a first embodiment of the coupling system with a helical groove in the cylindrical target. FIGURE 4 illustrates a first alternative to the first embodiment of the coupling system with a non-helical groove in the coupling system. FIGURE 5 illustrates a second alternative to the first embodiment of the coupling system with an interface ring with radially protruding parts.

Reference is first made to FIGURE 1, FIGURE 2 and FIGURE 3. A coupling system 10 is to releasably affix a cylindrical target 12 to a spindle 14. The target 12 may be provided with target material 13 to be sputtered. The spindle 14 terminates in a flange portion 16. The cylindrical target 12 has at its end a helical or spiral groove 18. The helix of the groove makes at least one revolution.

The coupling system 10 further comprises an interface ring 20. In this first embodiment the interface ring 20 is made of one single piece. This interface ring 20 has an inner diameter, which is greater or equal than the outer end diameter of the cylindrical target 12. The

Interface ring 20 has a circumferential inner surface 22, which is adapted to engage with the helical or spiral groove 18 of the cylindrical target 12. The interface ring 20 may be screwed over the cylindrical target 12. The interface ring 20 further has a flange extremity 24. In coupled status, the flange extremity 24 of the interface ring 20 abuts against the flange portion 16 of spindle 14. Preferably the flange extremity 24 has an inwardly protruding part 25. This protruding part 25 facilitates the positioning of the interface ring 20 to the target 12 since it may fit in a target recess at the extremity of the cylindrical target.

The coupling system 10 further comprises a clamping ring 26, which is composed of two or more clamp segments. Each clamp segment has an inwardly oriented clamp recess 28. In coupled status this clamp recess 28 encloses the flange portion 16 of spindle 14 and the flange extremity 24 the interface ring 20 in order to hold the cylindrical target 12 to the spindle 12. Preferably the surfaces of the flange portion 16 and of the flange extremity 24 are slightly conical. The clamp recess 28 has also matching conical surfaces.

The coupling system further comprises an O-sealing ring 30 in an O-ring groove 32 of the flange portion 16 and a sealing ring 34 in a groove of the spindle end 36.

A helical spring 38 is inserted in the helical or spiral groove 18. The spring 38 also meets with the circumferential inner surface 22 of interface ring 20. Spring 38 is not permanently fixed to the helical or spiral groove 18 and can be made of another material than the material of the cylindrical target 12 or the material of the backup tube of the cylindrical target 12.

The clamp segments of clamping ring 26 are held together by means of bolting means 40.

FIGURE 4 shows a detailed view of a cross-section of a first alternative to the first embodiment of the coupling system 10. The difference with FIGURE 3 is now that the cylindrical target 12 now has a non-helical groove 42. As a result the interface ring 20 has an inner circumferential surface 44 which matches this non-helical

groove 42. The interface ring 20 is here composed out of two or more segments in order to enable to mount the interface ring 20 on the cylindrical target 12.

FIGURE 5 shows a detailed view of a cross-section of a second alternative to the first embodiment of the coupling system 10. The differences with FIGURE 3 and FIGURE 4 mainly lie in the type of interface ring 20 and the type of clamping ring 26. The interface ring 20 now has radially protruding parts 200 and 202 which may take the form of a helix. The interface ring 20 fits in a cylindrical groove 42 of target 12. In order to prevent the interface ring 20 from rotating a pin 50 may be provided which fits into the target 12 and into the interface ring 20. Alternatively the pin 50 may be integrated with the interface ring 20 or with the target 12. The clamping ring 26 has been threaded at its inner side and may be screwed on the protruding helix 200, 202 of the interface ring 20 in order to clamp the cylindrical target 12 to the spindle 14.

FIGURE 6 shows a cross-section of a second embodiment of the coupling system 10. The target is provided with a groove 18 in the form of a helical thread. The difference with the first embodiment of FIGUREs 1 to 3 is now that the thread 18 is now positioned at the inside circumferential surface of the target 12.